Accelerator Physics Center Annual Meeting

High Intensity Neutrino Source Department Overview

Bob Webber

June 2, 2009

HINS Department Personnel

- Jean-Paul Carneiro – Particle tracking code development and Linac modeling
- Dave Johnson – Project X H- injection design and laser wire beam profile monitor
- Ken Koch – HINS MDB installations, Tevatron electronics support, and ProCard
- Robyn Madrak – 325 MHz beam chopper, cavity testing, and RF vector modulators
- Elmie Peoples-Evans – HINS controls & interlocks, LLRF, and SSR coupler testing
- Henryk Piekarz – Rapid cycling SC magnet R&D and HINS proton ion source system
- Jim Steimel – HINS RF systems, RFQ commissioning, and MDB operations
- Dave Wildman – RF vector modulators, RF testing, and ANU RR RF cavity design
- Bob Zwaska – Electron cloud investigations
- (Wai Ming Tam) – TD Graduate Student working on HINS
- Bob Webber

Phys Rev. Paper

PHYSICAL REVIEW SPECIAL TOPICS - ACCELERATORS AND BEAMS **12**, 040102 (2009)

Numerical simulations of stripping effects in high-intensity hydrogen ion linacs

J.-P. Carneiro*

Fermi National Accelerator Laboratory, Batavia, Illinois 60510, USA

B. Mustapha and P. N. Ostroumov

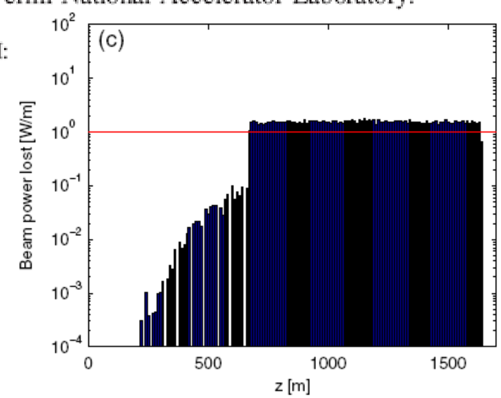
Argonne National Laboratory, Argonne, Illinois 60439, USA

(Received 12 December 2008; published 27 April 2009; corrected 20 May 2009)

Numerical simulations of H^- stripping losses from blackbody radiation, electromagnetic fields, and residual gas have been implemented into the beam dynamics code TRACK. Estimates of the stripping losses along two high-intensity H^- linacs are presented: the Spallation Neutron Source linac currently being operated at Oak Ridge National Laboratory and an 8 GeV superconducting linac currently being designed at Fermi National Accelerator Laboratory.

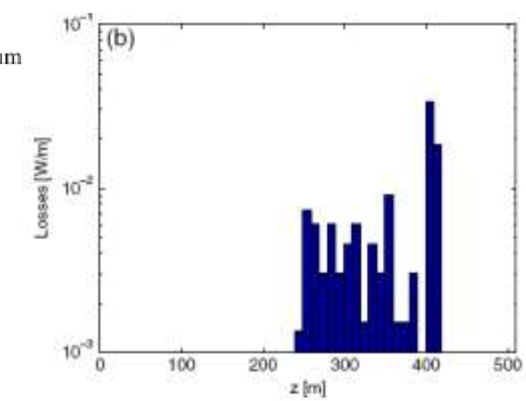
DOI:

BLACKBODY STRIPPING FNAL 8-GeV



PACS num

BLACKBODY STRIPPING SNS



NIM Paper

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ELSEVIER

Beam physics of the 8-GeV H^- linac

J.-P. Carneiro[a,*], B. Mustapha[b], P.N. Ostroumov[b]

[a] Fermi National Accelerator Laboratory, Batavia, IL 60510, USA
[b] Argonne National Laboratory, Argonne, IL 60439, USA

A R T I C L E I N F O

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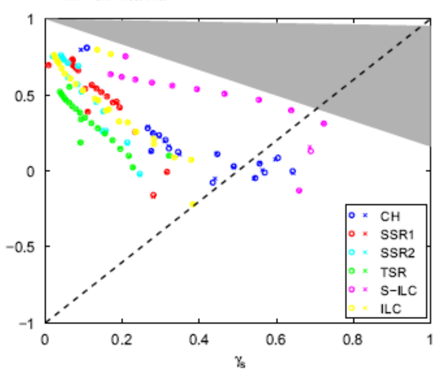
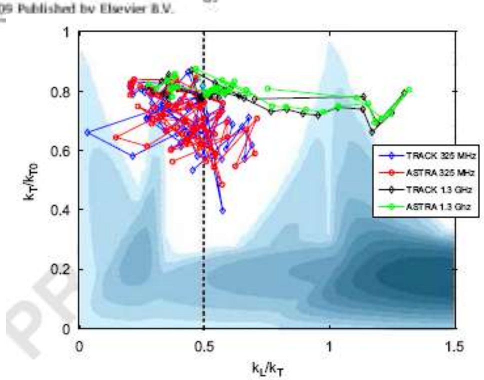
A B S T R A C T

Fermilab is developing the concept and design of an 8-GeV superconducting H^- linac with the primary mission of increasing the intensity of the Main Injector for the production of neutrino superbeams. The front-end of the linac up to 420 MeV operates at 325 MHz and accelerates the beam from the ion source using a room temperature radio-frequency quadrupole followed by short CH type resonators and superconducting spoke resonators. In the high-energy section, the acceleration is provided by superconducting elliptical 1.3 GHz cavities similar to the ones developed for the International Linear Collider (ILC). The beam physics for the linac is presented in this paper using two beam dynamics codes: TRACK and ASTRA.

KAPCHINSKIY STABILITY DIAGRAM



HOFMANN's CHART



Phys Rev. Paper
Special Edition HB2008

Physics design of front ends for superconduting ion linacs

P. N. Ostroumov
Argonne National Laboratory, Argonne, Illinois 60439 USA

J.-P. Carneiro*
Fermi National Accelerator Laboratory, Batavia, Illinois 60510 USA

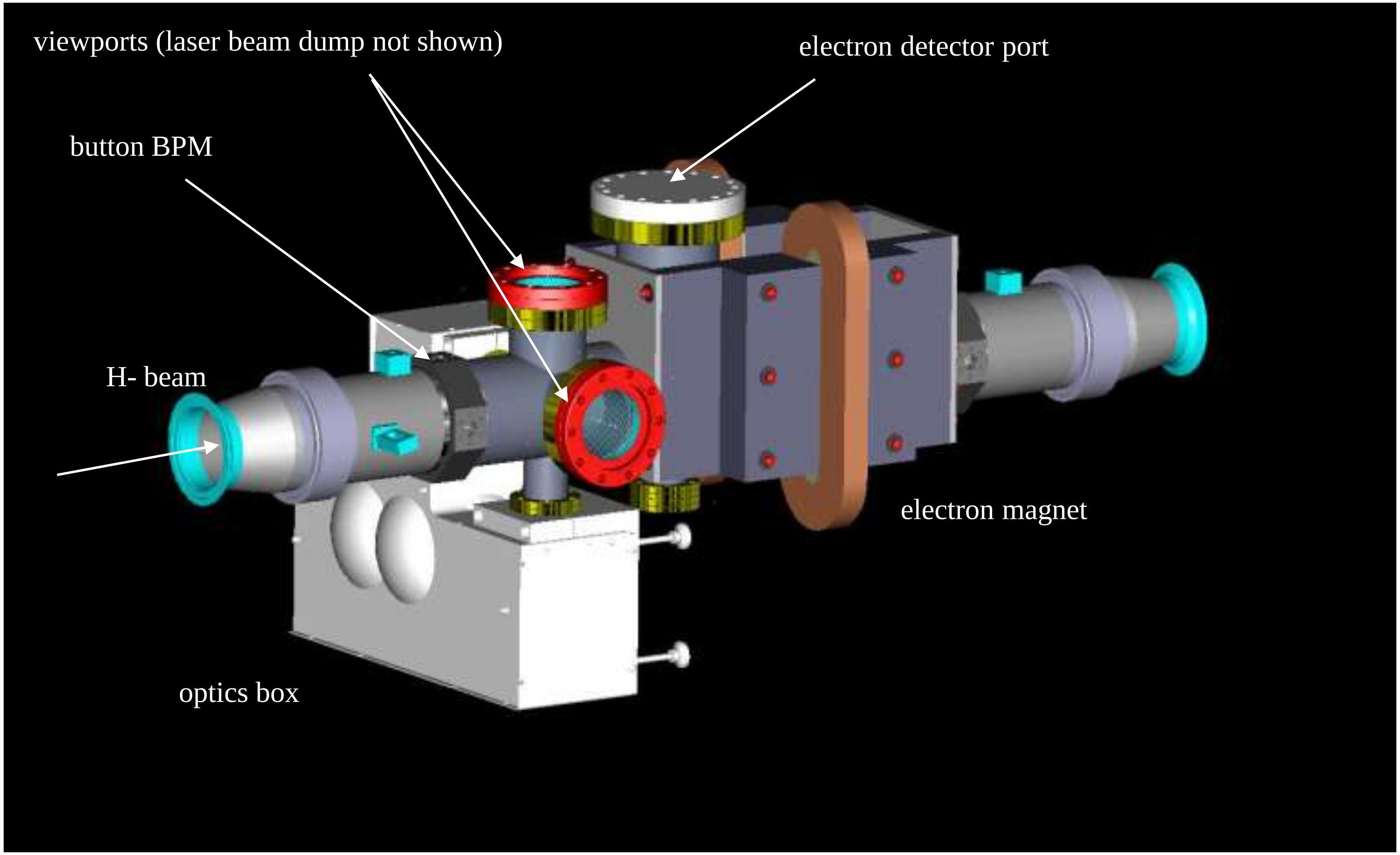
(Dated: January 30, 2009)

Superconducting (SC) technology is the only option for CW linacs and is also an attractive option for pulsed linacs. SC cavities are routinely used for proton and H^- beam acceleration above 185 MeV. Successful development of SC cavities covering the lower velocity range (down to 0.03c) is a very strong basis for the application of SC structures in the front ends of high energy linacs. Lattice design and related high-intensity beam physics issues in a ~400 MeV linac that uses SC cavities will be presented in this talk. In particular, axially-symmetric focusing by SC solenoids provides strong control of beam space-charge and a compact focusing lattice. As an example, we discuss the SC front-end of the H^- linac for the FNAL Proton Driver.

PACS numbers: 29.27.-a,41.75.Cn

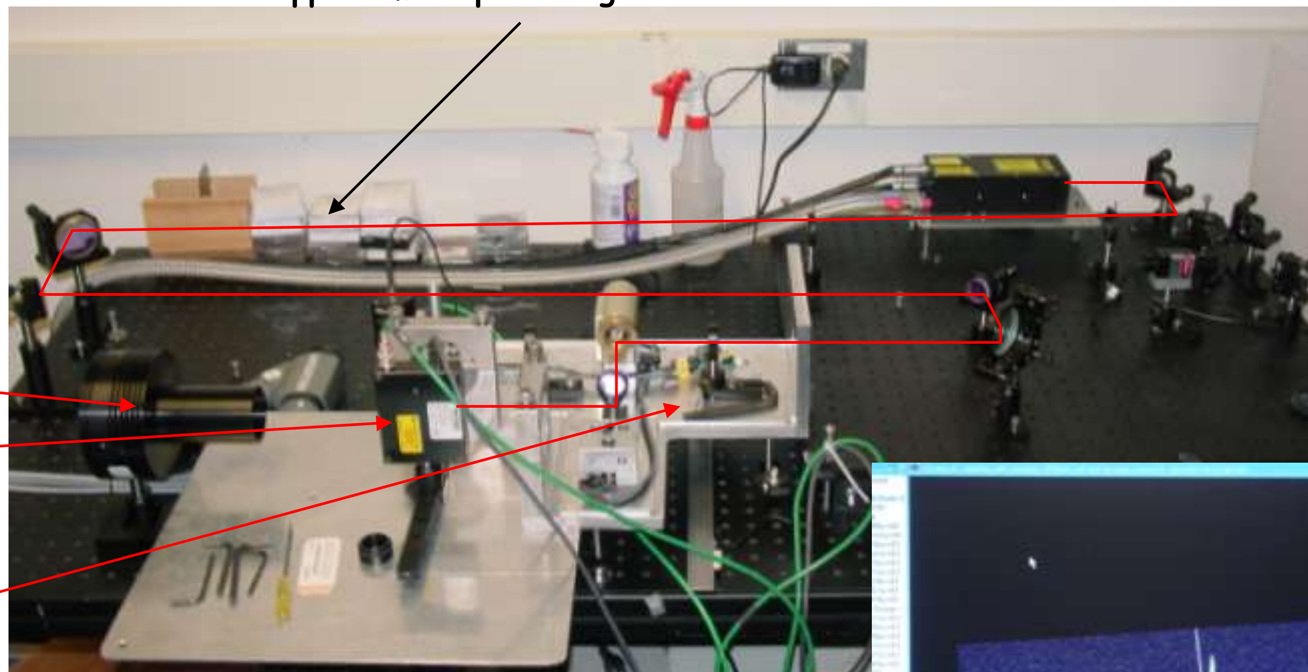
→ Why SC front-end and not NC (like CERN SPL, SNS, J-PARC,…)

H- Beam
Laser Wire Profile Monitor



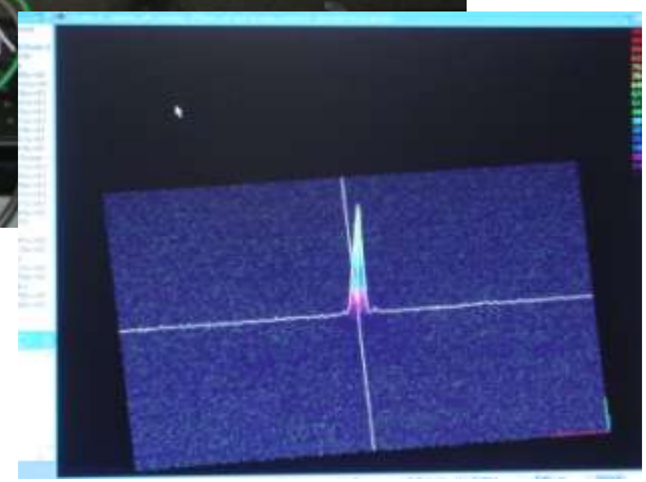
Characterizing Laser Optics

Approximate path length in tunnel installation



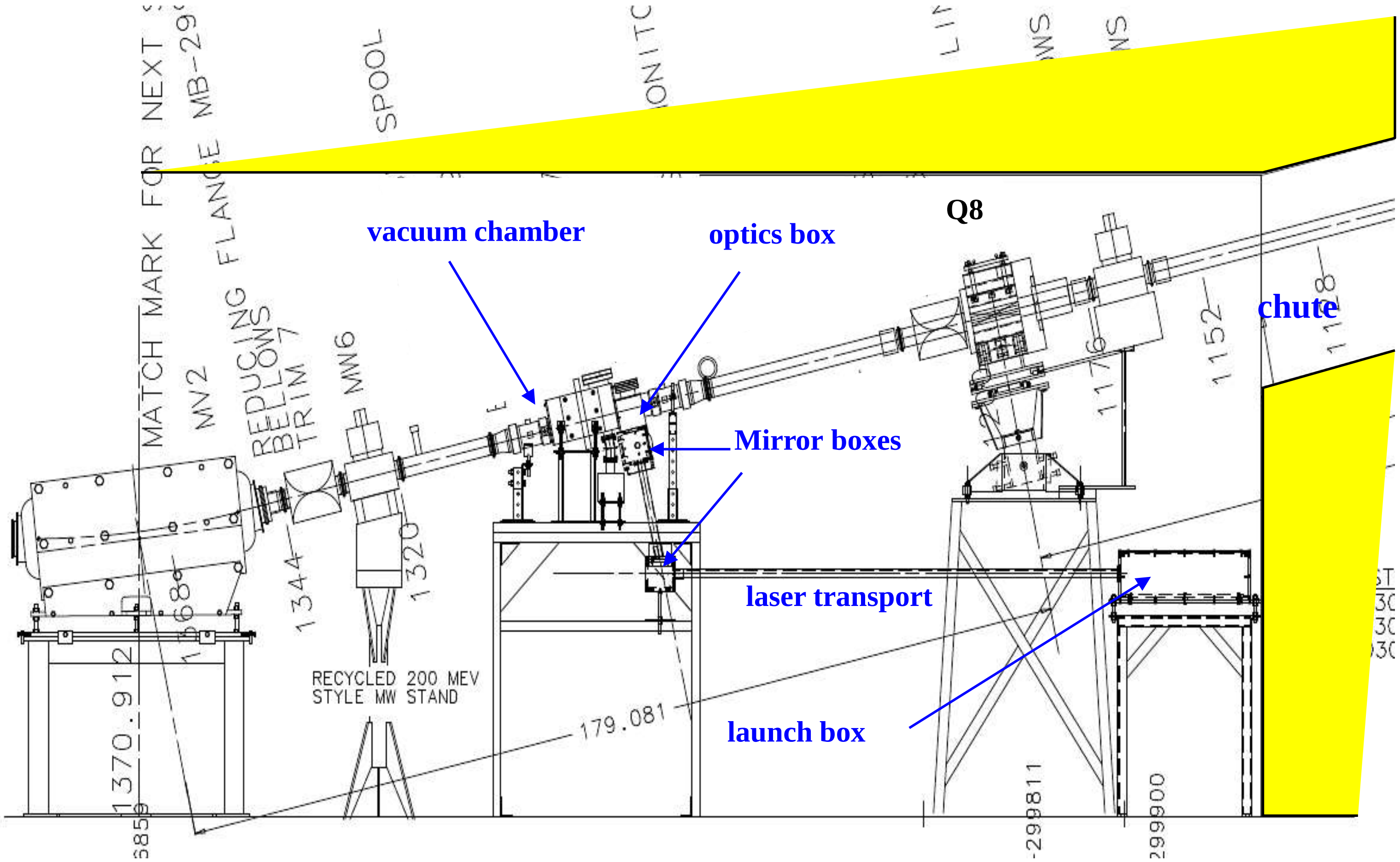
Beam size and energy measurement

Stripped down optics box



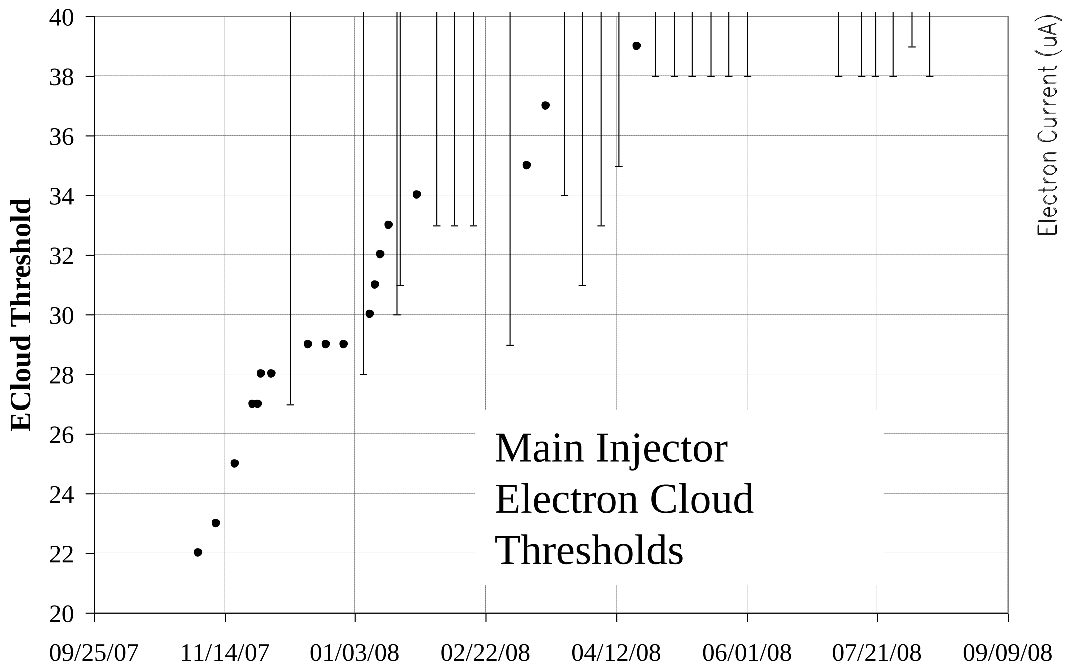
Spot size at focus
~100-200 microns

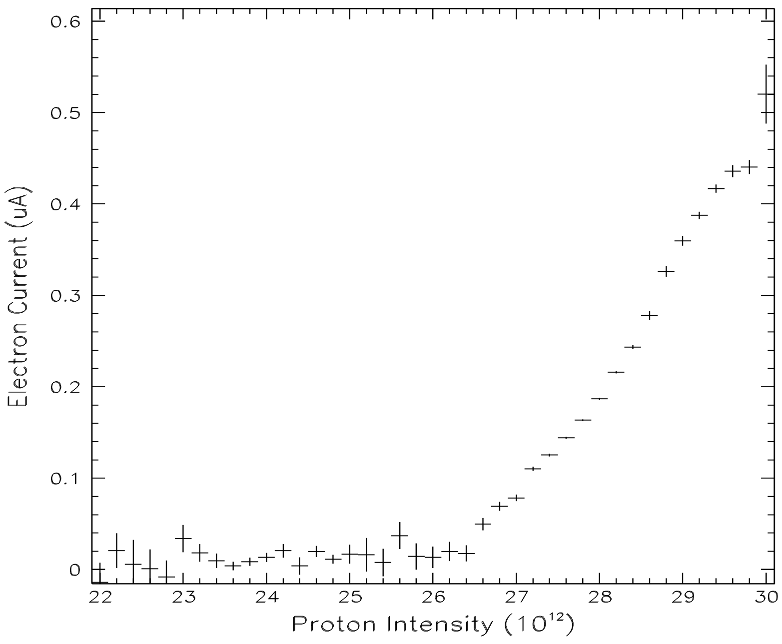
Planned 400MeV Line Installation



Electron Cloud Work

- ECloud observed in Main Injector
- Threshold effect
- Conditioning of pipe surfaces

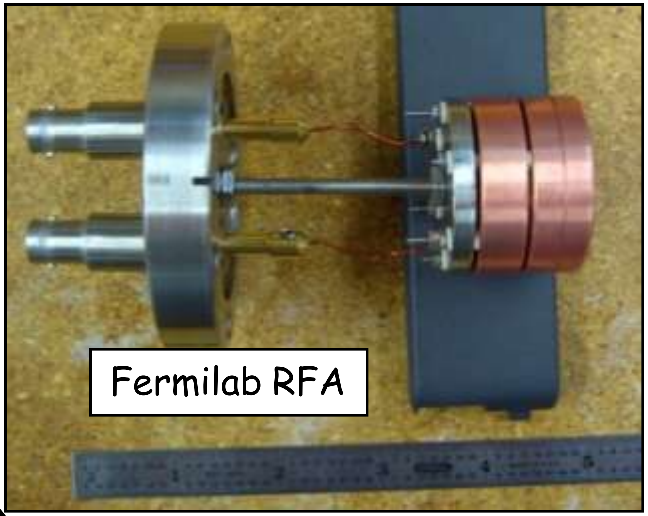


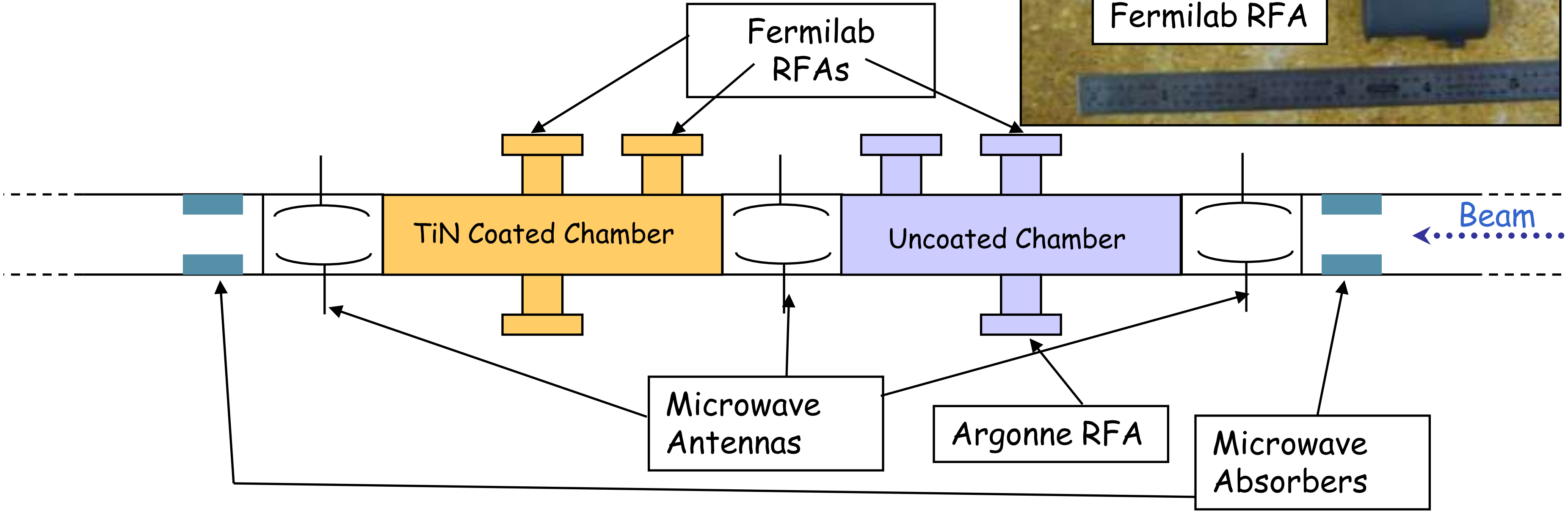


Electron Cloud Experimental Upgrade

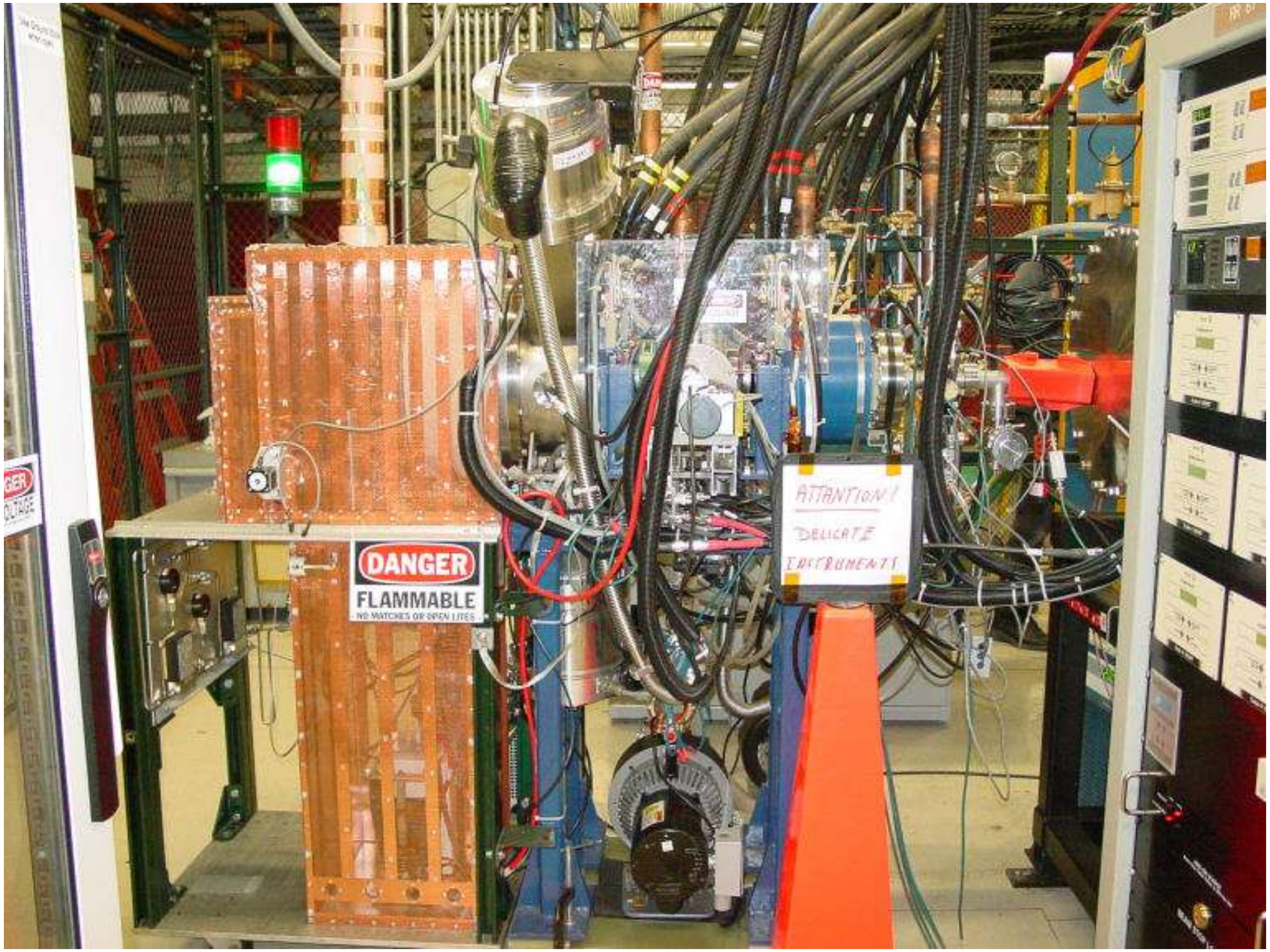
To be installed in Main Injector, Summer 2009 :

- 2 New experimental Chambers
- 3 Fermilab and 1 Argonne RFA
- 3 microwave antennas and 2 absorbers

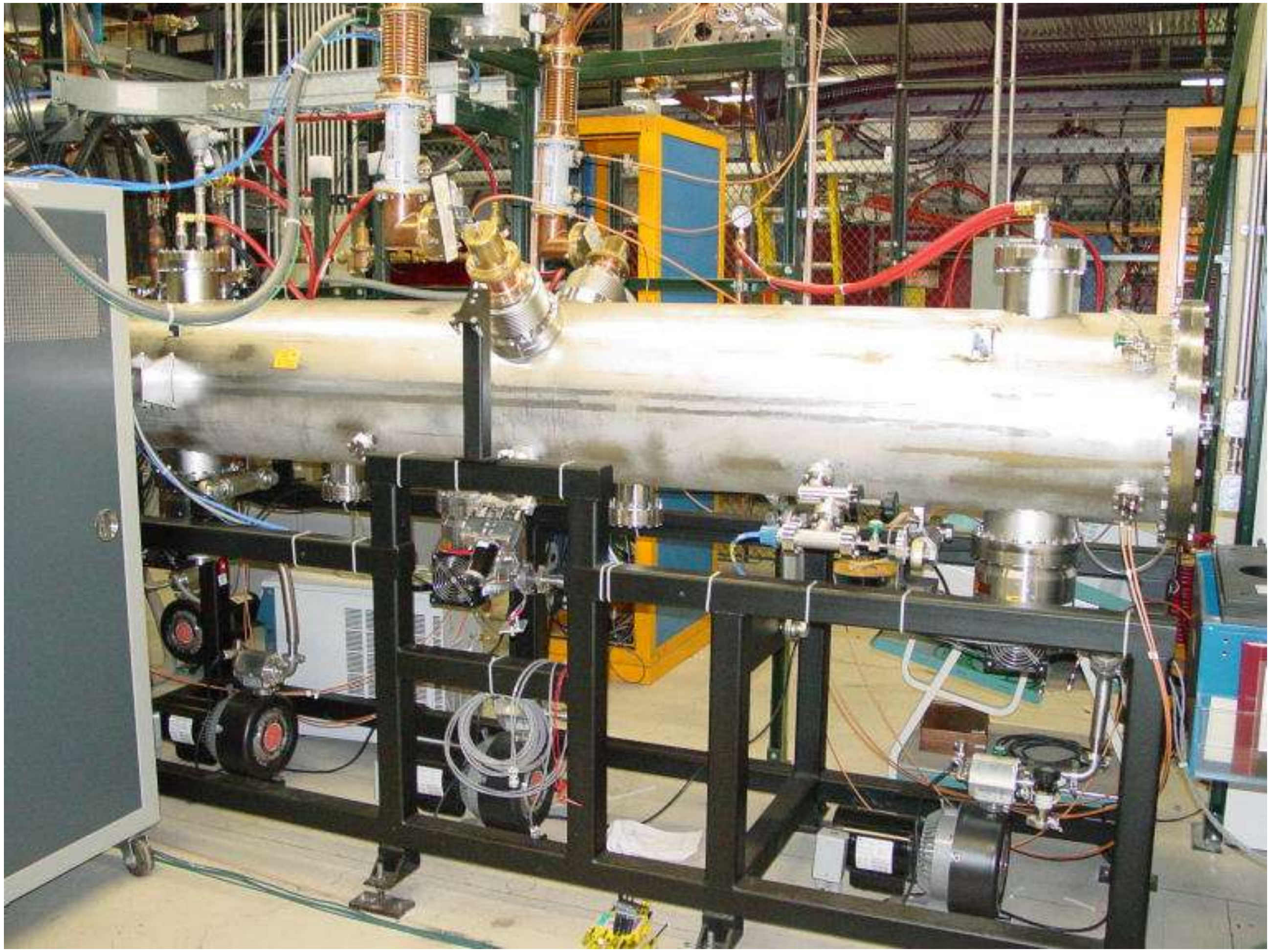




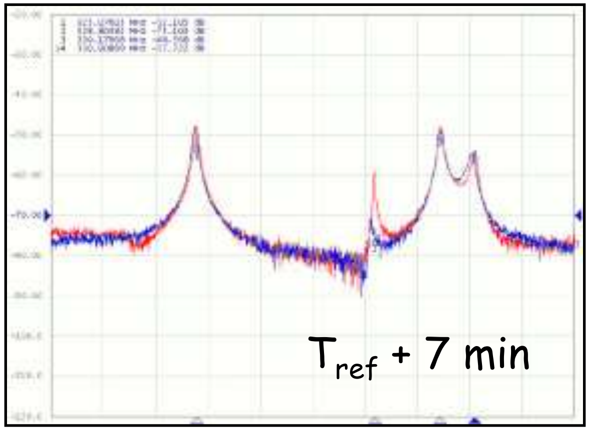
Ion Source Installed in MDB

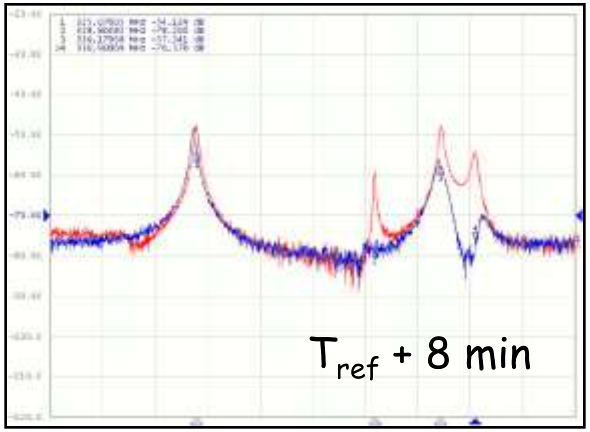


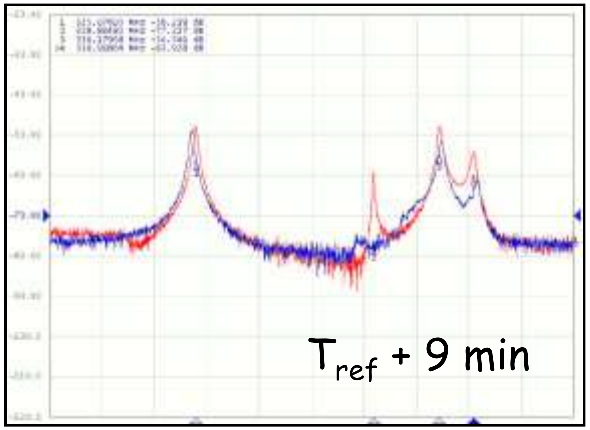
RFQ Installed in MDB

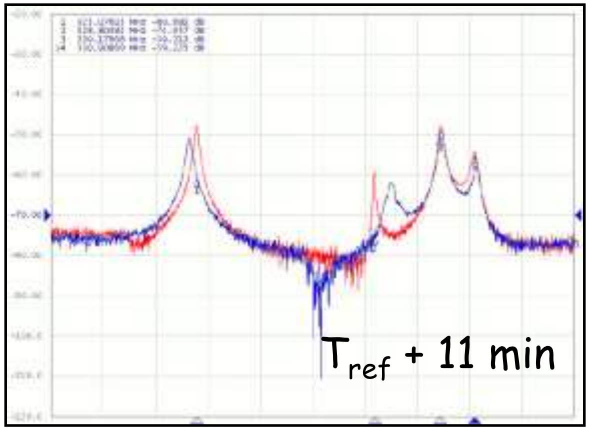


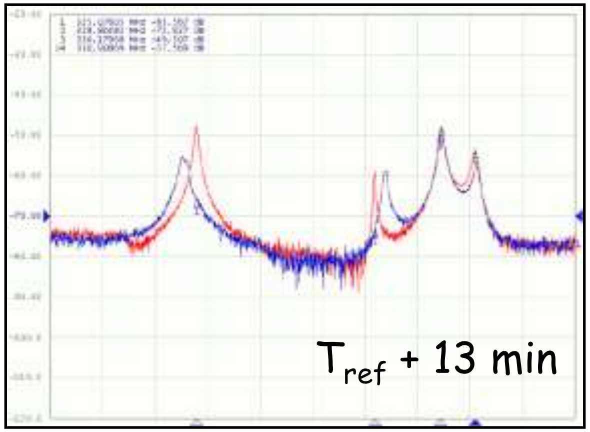
Progression of Detuning

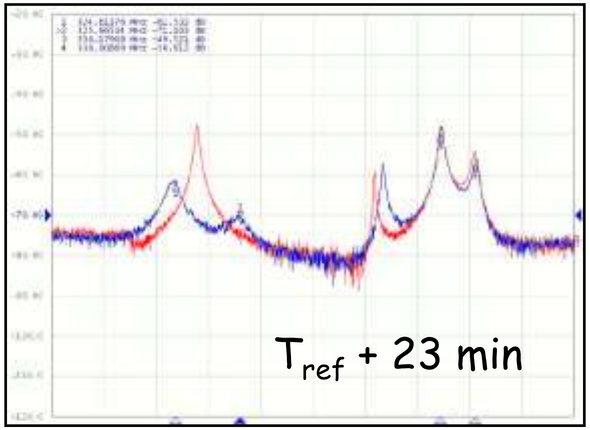




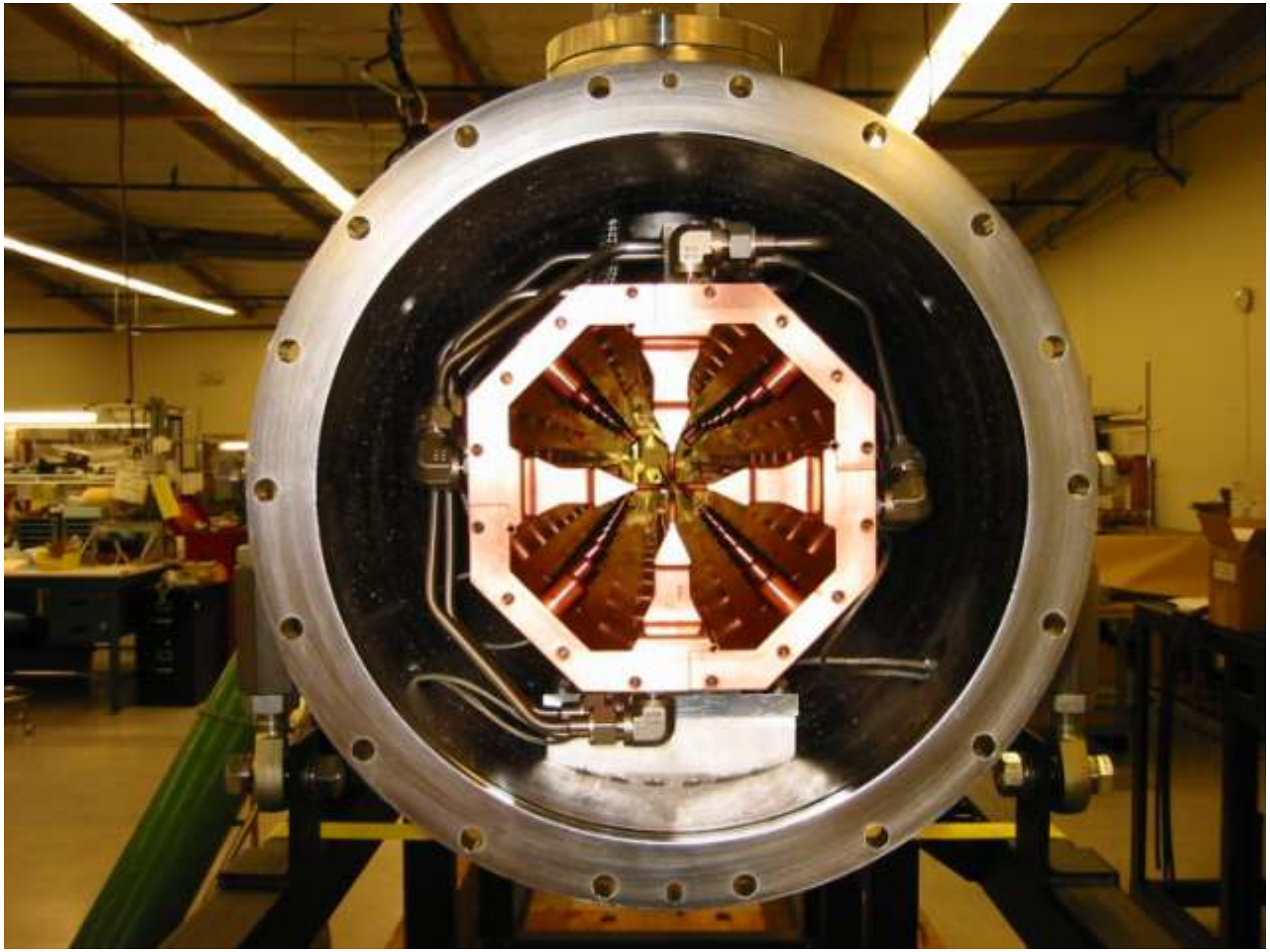




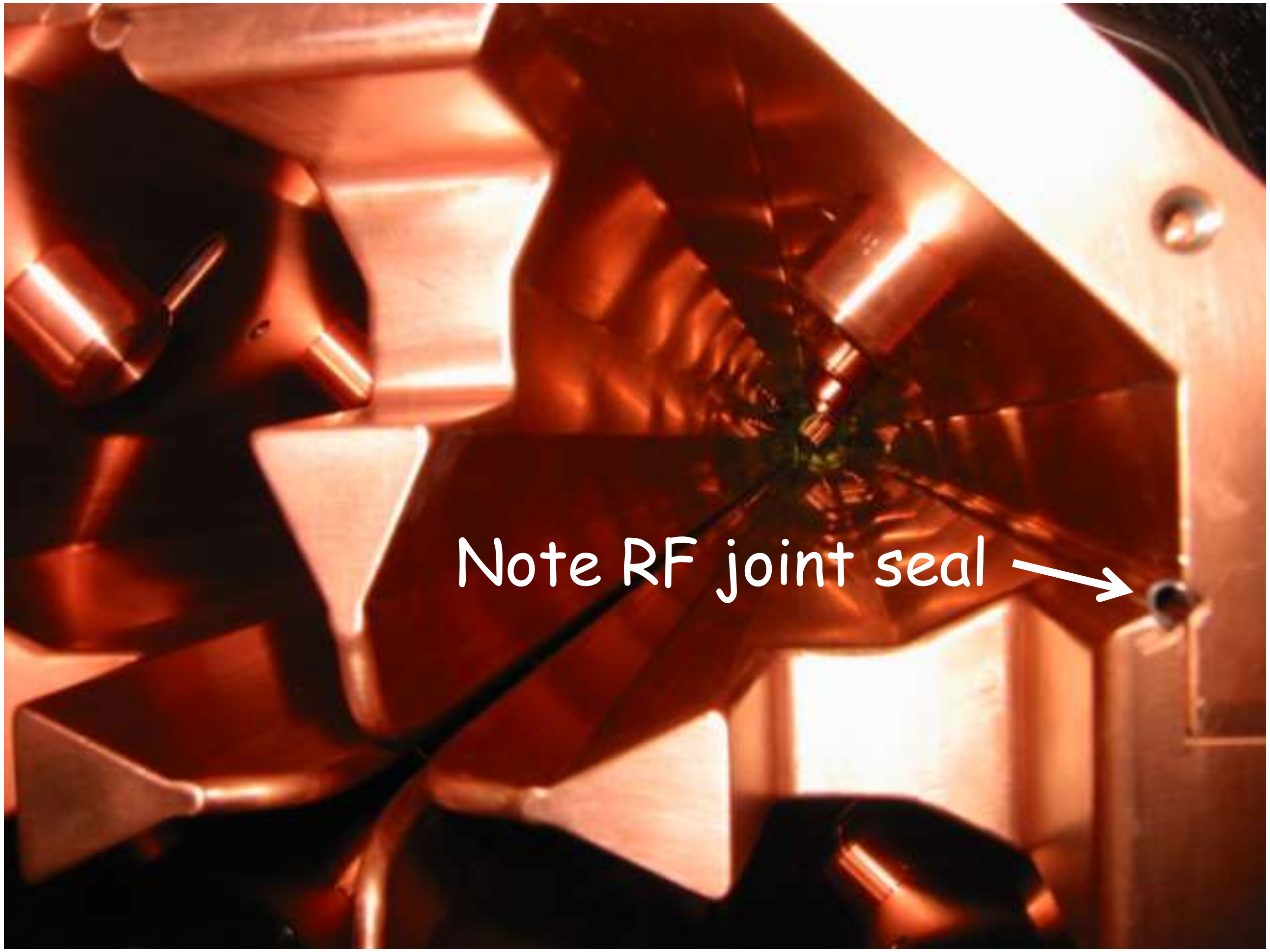




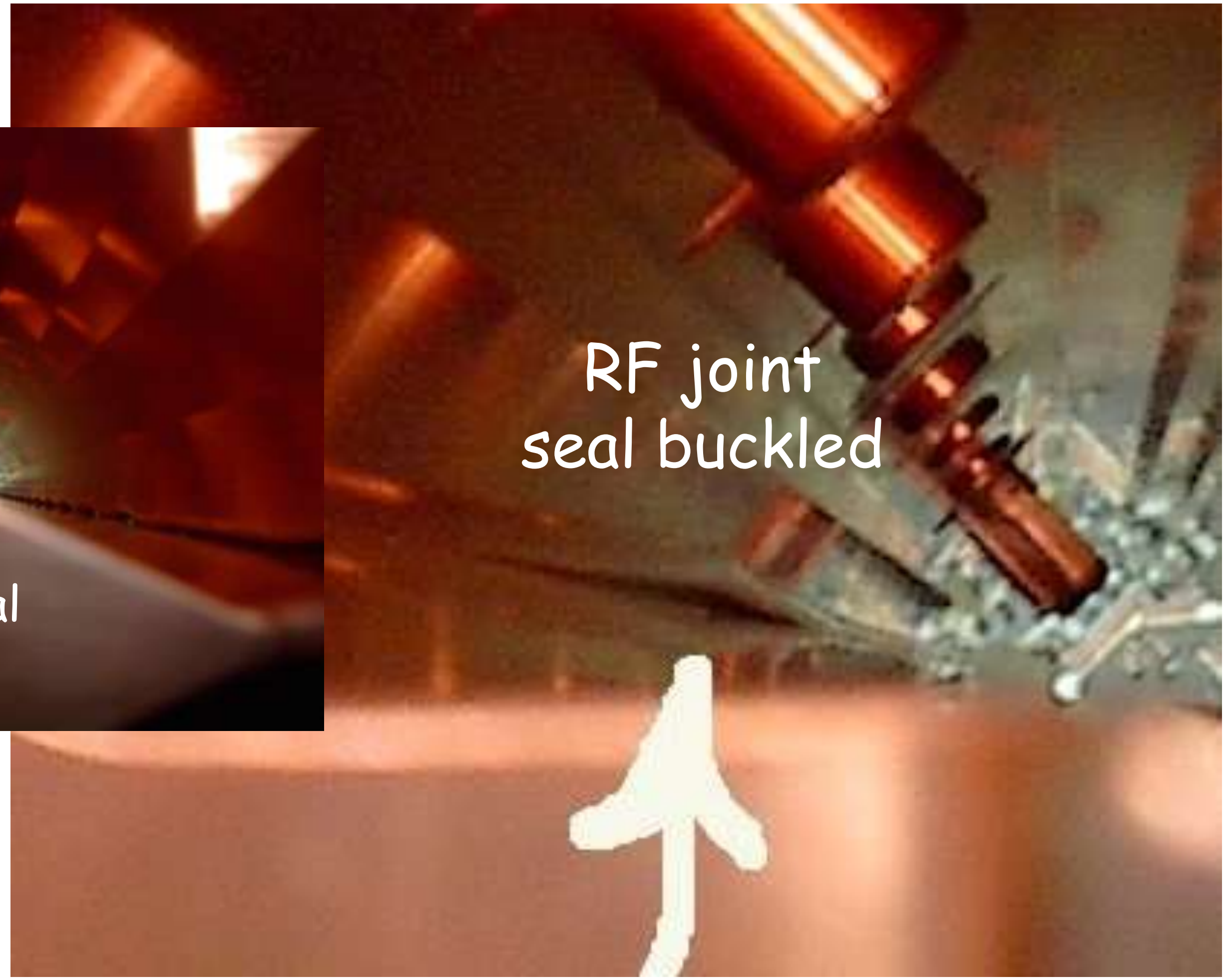
RFQ in Vacuum Tank

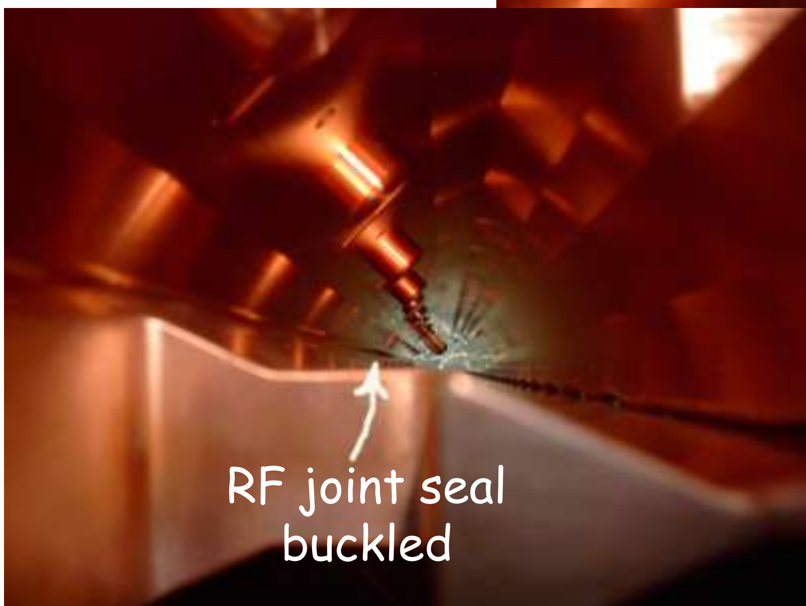


RFQ Close-up

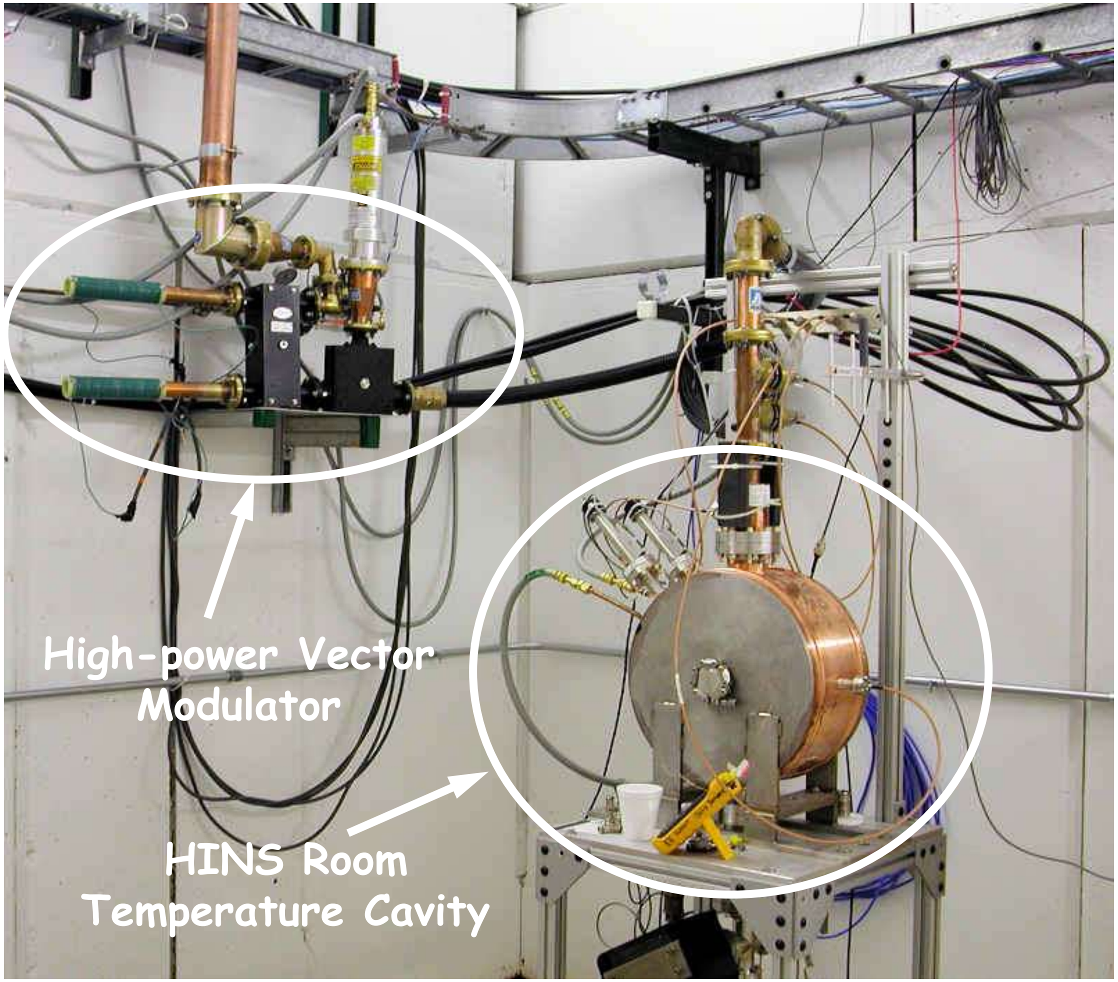


RFQ RF Joint Failure

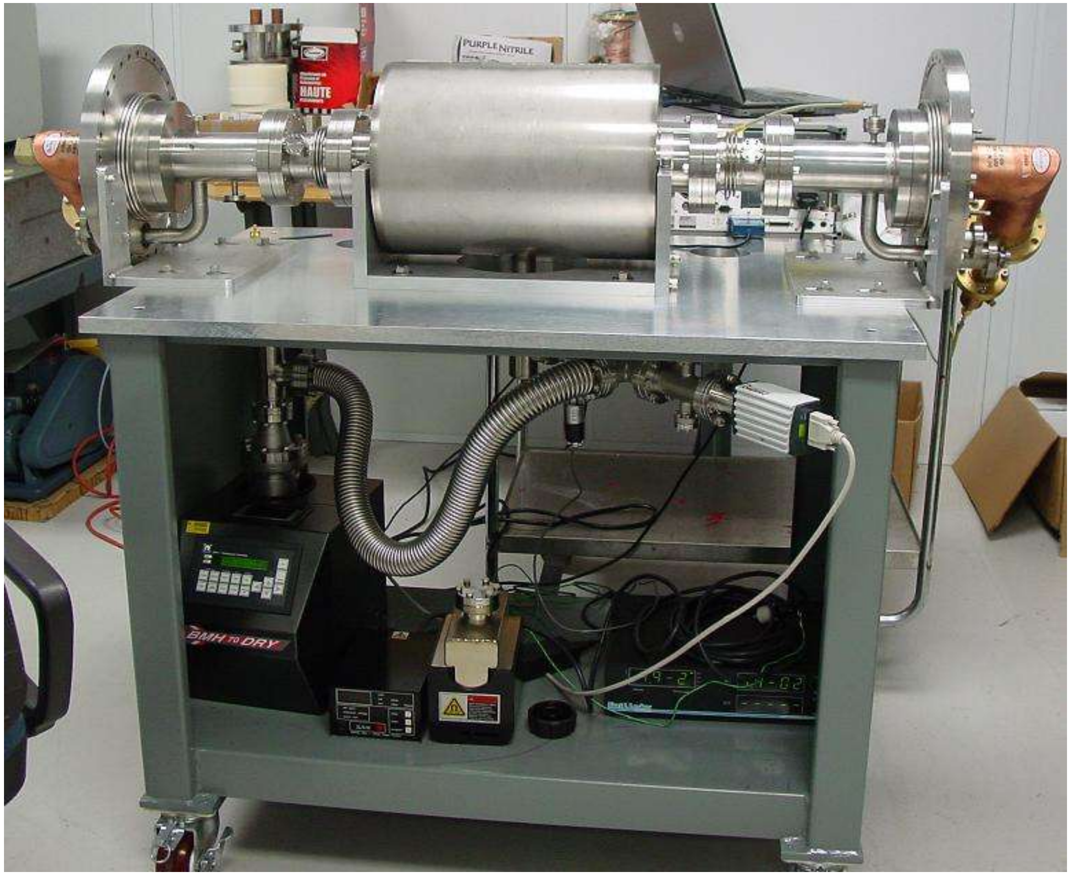




HINS RT Cavity & Vector Modulator

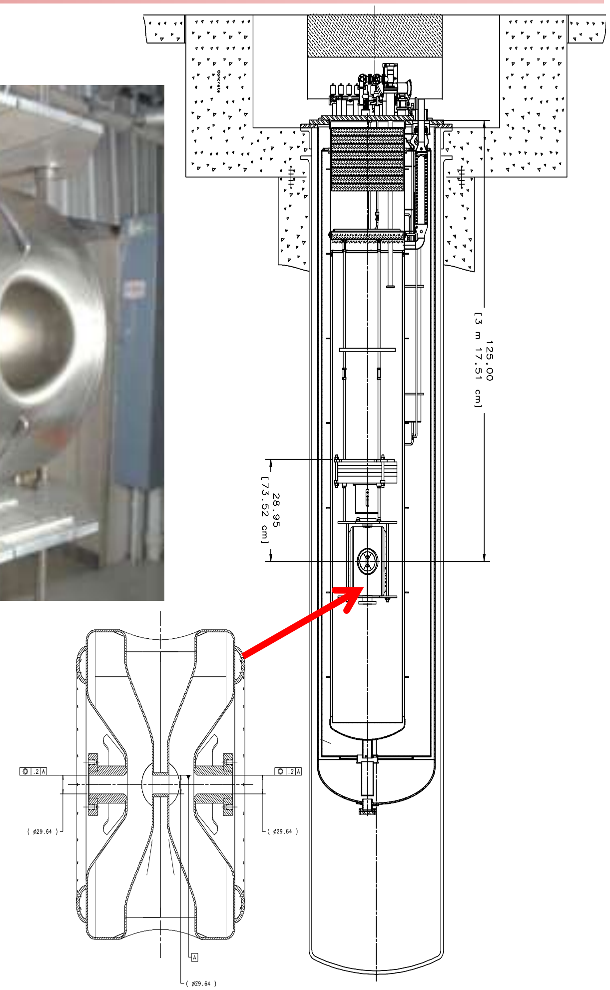


Spoke Cavity Input Coupler Test Stand

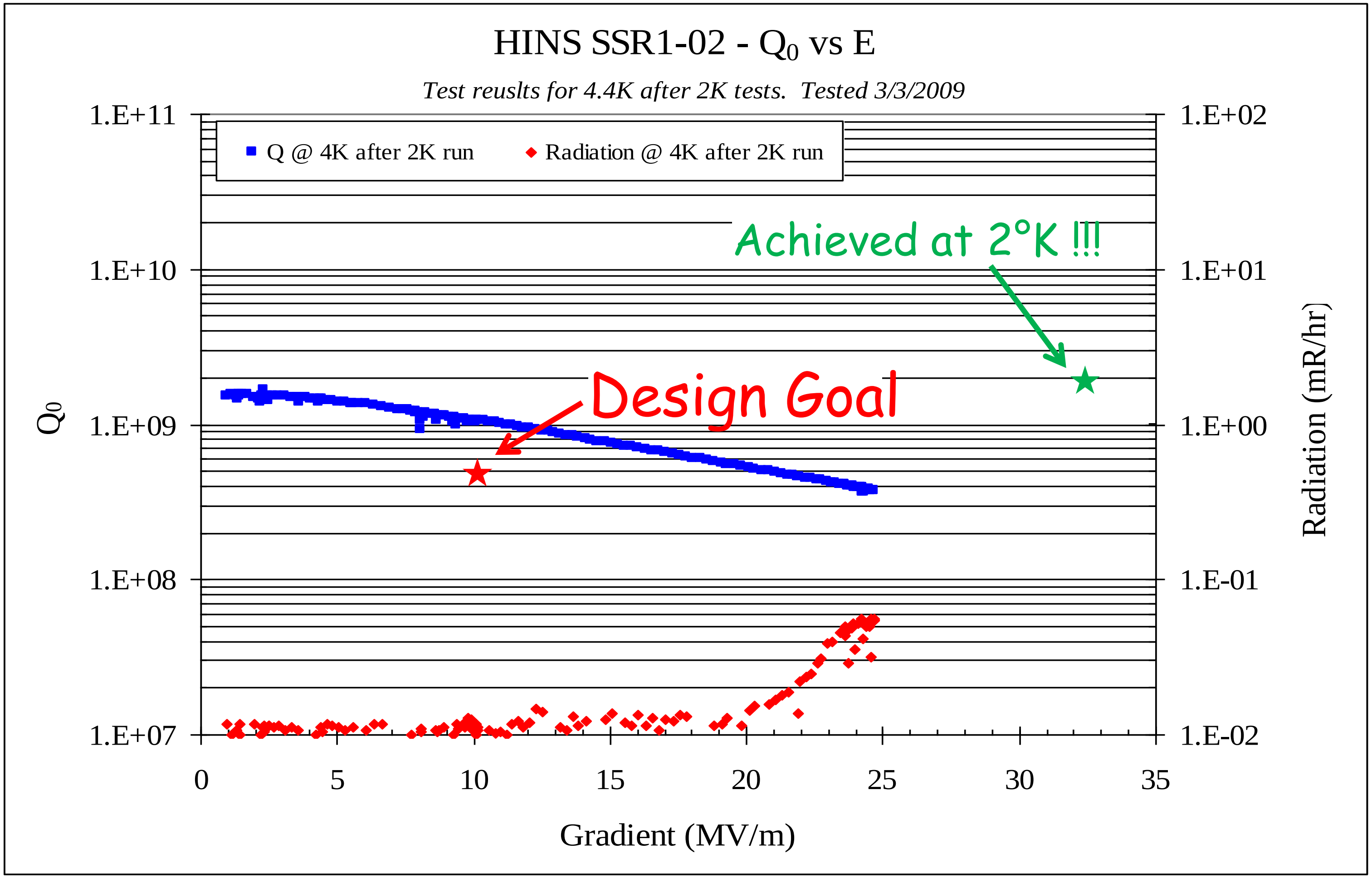


First full-power coupler tests have been successfully completed

Spoke Cavity in VTS



SSR1-02 in VTS

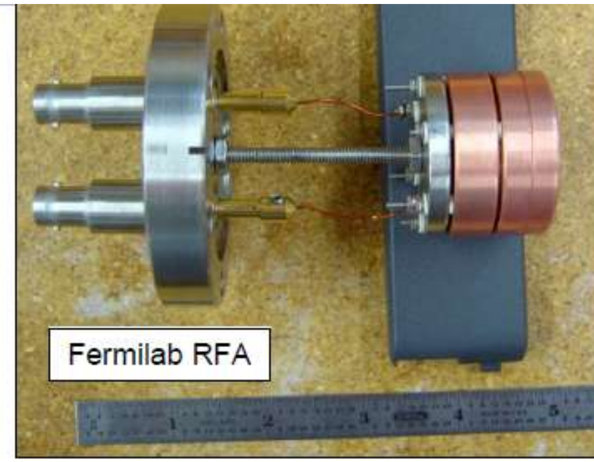


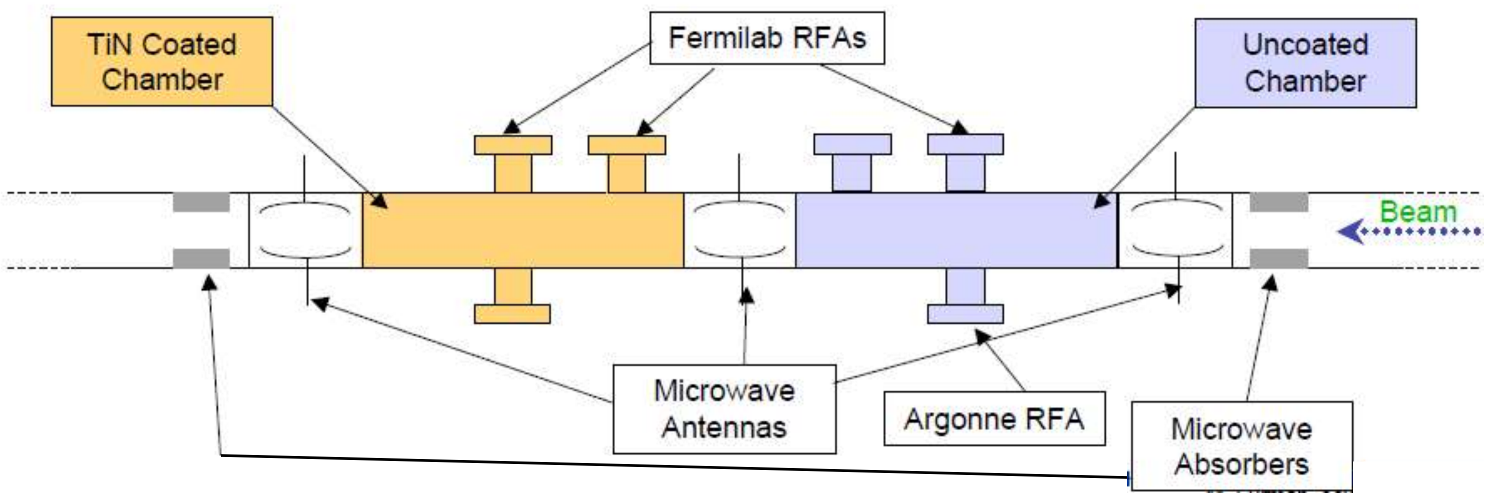
Summary

LOTS OF EXCITING ACTIVITY UNDERWAY IN THE APC HINS DEPARTMENT !!!

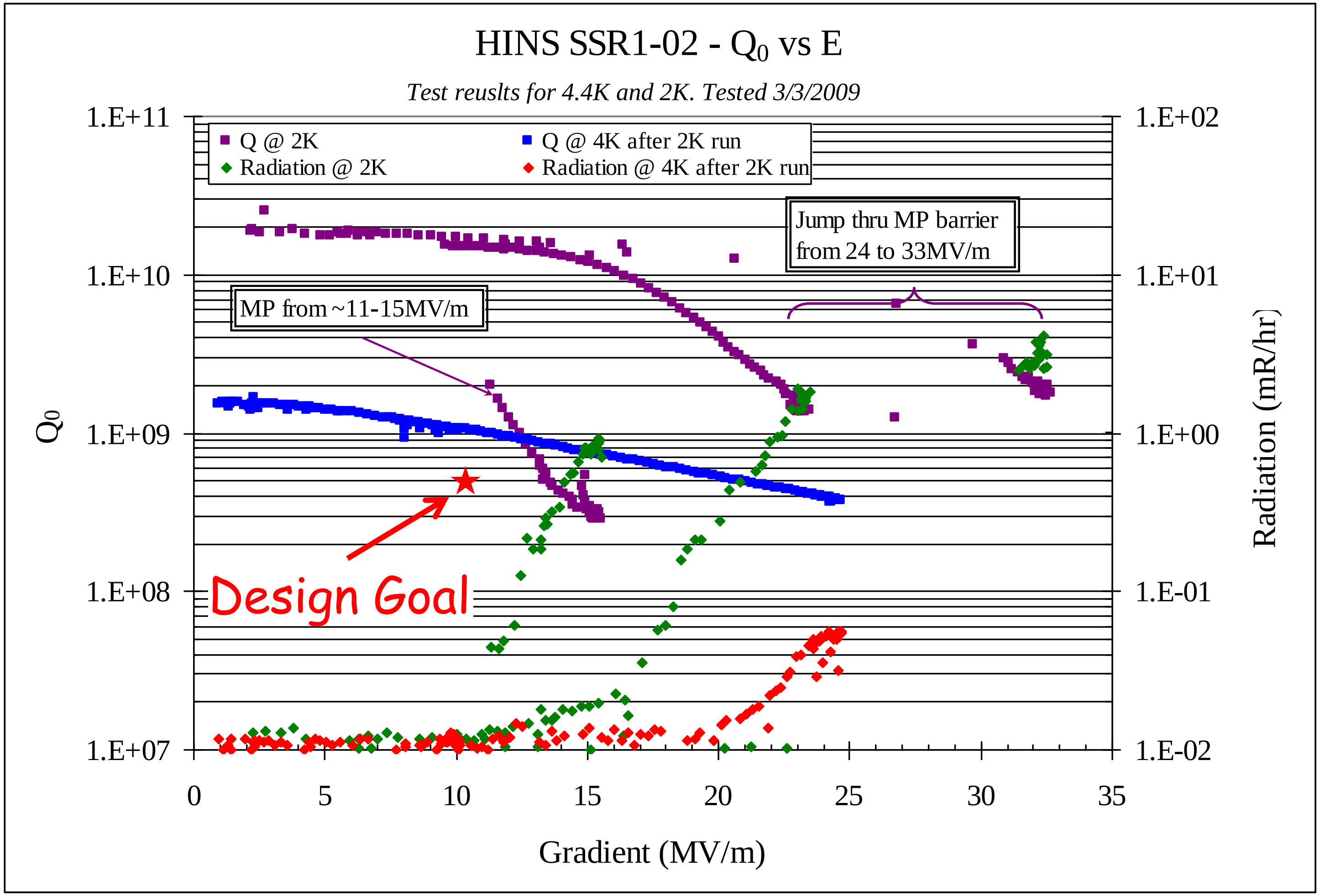
Bob Zwaska's e-cloud Work

To be installed in Main Injector, Summer 2009 :
- 2 New experimental Chambers
  - — Test TiN coating for ECloud suppression
  - — Measure spatial extinction of ECloud
- 3 Fermilab and 1 Argonne RFA
  - — Retarding Field Analyzers
  - — Directly measure electron flux
    - Compare designs
- 3 microwave antennas and 2 absorbers
  - — Measure ECloud density by phase delay of microwaves





SSR1-02 in VTS



Goals of HINS Program

- Stated Mission - To address accelerator physics and technology questions for a new concept, low-energy, high intensity, long-pulse H- superconducting Linac; in particular, to demonstrate:
  - beam acceleration using superconducting spoke-type cavity structures starting at a beam energy of 10 MeV
  - multiple high power RF vector modulators controlling RF cavities driven by a single high power klystron for acceleration of a non-relativistic beam
  - beam halo and emittance growth control by the use of solenoid focusing optics
  - a fast, 325 MHz bunch-by-bunch, beam chopper
- The current scope of HINS includes two CM of $\beta = 0.2$ SSR1 spoke cavities to achieve 30 MeV